

## PIVOTAL PLANT PROTECTOR

Sub A1 → The present invention relates to a string trimmer and in particular to a mechanism for shielding plants from the cutting path swept out by the rotating cutting line of the string trimmer.

5 String trimmers are portable hand-held outdoor gardening power tools, used for domestic and commercial grass cutting and are powered by electrical motors or small combustion engines. A string trimmer has a cutting head from which extends a cutting line, the cutting line commonly being a flexible plastic wire. The cutting line extends radially from the axis of rotation of the cutting head when it is rotatably  
10 driven by a motor. In the usual cutting mode, the cutting head and cutting line rotate a high rotational speed about an approximately vertical axis. The rotating cutting line is placed in close proximity to the grass to be cut. The grass caught within the path swept out by the rotating cutting line is severed when impacted by the cutting line.

15 This method of cutting grass is quick and highly effective and can be employed in dense grass or on a household lawn.

Indiscriminate cutting of soft vegetation may not be a problem when cutting in certain locations. However, the string trimmer may be used in a location where there  
20 is a mixture of soft vegetation where some parts need to be cut and other parts need to be left. One example is where the verge of a lawn abuts a flower bed containing small and delicate flowers which overhang the grass. In this example a string trimmer cannot be used easily to cut the grass without damaging overhanging flowers that are also caught in the path swept out by the rotating cutting line.

25 The example cited above illustrates a situation when the user wishes to protect certain plants from the rotating cutting line. There are, however, instances when the user wishes to protect the rotating cutting line from coming into contact with hard objects that the cutting line was not intended to cut, such as rocks or stones. When the  
30 rotating cutting line makes contact with such objects, it is liable to be damaged and

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therefore would need to be replaced. This situation is also undesirable and a device which protects certain plants from the rotating cutting line should also be capable of protecting the rotating cutting line from damaging itself against hard objects.

5 Prior art document EP 0 893 050 discloses a length of rigid metal wire attached to and extending outwardly from the motor housing of a string trimmer and is adapted to form a guard surrounding part of the path swept out by the rotating cutting line. EP 0 893 050 further discloses that the wire can also act as an edging guide. When acting as an edging guide, the rotating cutting line can cut a uniform edge along a lawn edge  
10 or a curb without coming into contact with the lawn edge or curb.

However, there are two problems associated with the guard disclosed in EP 0 893 050. The metal wire, when acting as a guard, does not surround the path swept out by the rotating cutting line. This leaves ample space for vegetation, such as  
15 overhanging plants or flowers, to enter into the path swept out by the rotating cutting line which results in damage to this vegetation.

Secondly, when the string trimmer is used in edging mode, the metal wire acts as a guide and therefore is unable to act as a guard. As such no protection is provided  
20 against cutting vegetation which is not intended to be cut.

According to the first aspect of the present invention there is provided a string trimmer comprising an elongate shaft; a cutting head rotatably mounted on one end of the elongate shaft at least one cutting member which extends from the cutting head  
25 and a barrier which is capable of being used by an operator to move vegetation away from a path swept out by the cutting member when it rotates characterised in that the barrier is pivotally mounted about a single axis on the string trimmer and, when the cutting head is rotating in a flat cutting position, is capable of pivoting from a position above the path swept out by the cutting member to a position below the path swept out  
30 by the cutting member without passing through the path swept out by the cutting member.

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The string trimmer according to the present invention can provide a lightweight plant protector which can be pivotally moved between a plurality of positions without the need of dismantling any part of the string trimmer. When in use, a primary function of the plant protector is to provide a barrier between overhanging plants and the path swept out by the rotating cutting line, while still allowing low level vegetation like for example grass, to pass below the lower edge of the plant protector and into the path of the rotating cutting line. A plant protector according to the present invention can have two 'in-use' positions; one position for flat cutting and, the other for vertical edge trimming, such that when located in both 'in-use' positions the lower edge of the plant protector is approximately horizontal when the string trimmer is used in the appropriate way. This is achieved by pivotally mounting the barrier onto the string trimmer. This plant protector provides a barrier which pushes away any overhanging plants from the path of the cutting member as the string trimmer advances towards them. While protecting overhanging plants from the rotating cutting line, the plant protector also protects the rotating cutting line from unnecessary contact with hard objects, like for example stone, which can damage and shorten the life span of the cutting line.

However, the user may wish to "shoe" the plant protector on the string trimmer putting it out of use whilst maintain it attached to the string trimmer by pivoting the plant protector to an 'out-of-use' position. As the plant protector remains pivotally attached to the string trimmer is ready for immediate use by an operator to shield plants from the path swept out by the cutting member.

Ideally, the axis of pivot is perpendicular to the axis of rotation of the cutting head both when it is located in a flat cutting position or a vertical edging position.

The barrier may be capable of pivoting through at least 270° and also from a first position where it is located on one side of the elongate shaft to a second position

where it is located on the other side of the elongate shaft. By constructing the barrier in this manner, it pivots through the whole range positions excluding that occupied by the shaft of the string trimmer.

5       The string trimmer can have suitable dimensions so that it is capable of surrounding the edge of the path swept out by the cutting member when it rotates irrespective whether the cutting head is in a flat cutting position or a vertical edging position.

10       The barrier can be capable of pivoting to a position wherein it projects forward, downward or rearward of the string trimmer.

15       Ideally the string trimmer comprises a guard, the barrier being capable of pivoting to a position where it surrounds the rear of the guard. Preferably the barrier is pivotally mounted on the guard.

Alternatively, the barrier being capable of pivoting to a position where the guard surrounds at least part or all of the barrier.

20       The barrier can be pivotally mounted on the string trimmer at each end of its ends by pivot mechanisms.

25       The barrier can be in the form of a band which is pivotally mounted at each of its ends and can curve from one pivot point around to the other pivot point.

According to a second aspect of the present invention, there is provided a barrier for use on a string trimmer comprising  
 an elongate shaft;  
 a cutting head rotatably mounted on one end of the elongate shaft;  
 30   at least one cutting member which extends from the cutting head  
 the barrier being capable of being used by an operator to move vegetation away from a path swept out by the cutting member when it rotates characterised in that the barrier

is capable of being pivotally mounted on a string trimmer about a single axis in a manner where it can pivot from a first position above a path swept out by a cutting member to a second position below a path swept out by a cutting member without passing through the path swept out by a cutting member, when the cutting head is rotated in a flat cutting position.

Three embodiments of the present invention will now be described, with reference to the following drawings, of which:

10        Figure 1 shows a perspective view of a string trimmer with the plant protector in a storage position in accordance with the first embodiment;

Figure 2 shows a side view of the motor housing and guard of the string trimmer in cutting mode with the plant protector in a storage position;

15        Figure 3 shows a side view of the motor housing and guard of the string trimmer in cutting mode with the plant protector in the "flat cutting" position;

Figure 4 shows a side view of the motor housing and guard of the string trimmer in edging mode with the plant protector in the "vertical edge cutting" position;

Figure 5 shows an exploded view of the cap and part of the plant protector from one side;

20        Figure 6 shows an exploded view of the cap and part of the plant protector from the other side to that shown in Figure 5;

Figure 7 shows a view of the cap and part of the plant protector when assembled from the same side as that shown in Figure 6;

25        Figure 8 shows a view of the cap and part of the plant protector when assembled from the other side as that shown in Figure 7;

Figure 9 shows an exploded view of cap and guard;

30        Figure 10 shows a side view of the motor housing and guard of the string trimmer in a cutting mode with the plant protector in a position where it surrounds the edge of the path swept out by cutting line in accordance with the second embodiment of the invention;

Figure 11 shows a view of part of the plant protector showing the circular collar; and

Figure 12 shows a side view of the motor housing and guard of a string trimmer in cutting mode with the plant protector in the storage position according to the third embodiment of the present invention.

5        Figures 1 to 9 show the first embodiment of the invention and which will now be described.

Referring to Figure 1, a string trimmer (10) comprises an elongate shaft (13), a rear handle (11) attached to one end of the elongate shaft (13), an electrical trigger switch (12) located below the rear handle (11), a front support handle (14) attached part way along the elongate shaft (13), an electrical cable (15) capable of carrying electrical current and entering the elongate shaft (13) at a location below the rear handle (11), a motor housing (16) attached to the other end of the elongate shaft (13) in which is mounted an electric motor (not shown), a semi-circular protection guard (17) attached to the motor housing (16) having a semi-circular edge (174), a cutting head (18) rotatably driven by the electric motor, a cutting line (19) which extends from the cutting head (18), and a plant protector (20) pivotally attached to the protection guard (17) at two pivot points (211;212) in symmetrical fashion.

20        When operating the string trimmer (10) the user stands in an upright position, holding the weight of the string trimmer (10) by the rear handle (11) and directing the cutting head with the front support handle (14), the elongate shaft (13) extending downwardly from the rear handle (11) towards the motor housing (16) and the ground. The cutting head (18) is located in close proximity to, but clear of, the ground and is rotatably driven by the electric motor when the electric motor is energised by the user. Electrical current supplied by the electrical cable (15) is supplied to the electric motor via the electrical switch (12), the electrical switch (12) connecting or disconnecting the electrical supply to the electric motor when operated by the user. When connected to the electrical current supply the electric motor is energised and rotatably drives the cutting head (18) and the cutting line (19). Conversely, disconnection of the electrical current supply de-energises the electric motor which results in the rotation of the cutting head (18) and cutting line (19) ceasing. The

cutting line (19) is a strong elongate filament, like for example, plastic wire, which extends radially from the cutting head (18). When the cutting head (18) is rotatably driven by the electric motor, the cutting line (19) turns with the cutting head (18) about the same axis and sweep at a circular path cutting any soft vegetation, for example grass, which enters the path swept out by the rotating cutting line (19).

The protection guard (17) is part circular in shape and is adapted to surround part of the path swept out by the line on the side of the string trimmer (10) where the user normally stands during operation. By surrounding the cutting path the protection guard (17) prevents the user from accidentally placing their foot within the path of the rotating cutting line (19). The part of the path swept out by the cutting line on the other side of the motor housing (16) is exposed so that any grass or soft vegetation falling within the path will be cut.

The plant protector (20) is mounted so that it pivots about an axis which is perpendicular to the axis of rotation of the cutting head (18) when it is in its flat cutting position as shown in Fig 2 and also when it is in its vertical edge cutting position as shown in Fig 4.

The plant protector (20) is able to be pivoted from the first position (not shown) where it is adjacent the elongate shaft (13) located just forward of the elongate shaft (13) through an angle of over 270° first to a position forward of the string trimmer (see Fig 3) to a position below the string trimmer (not shown), to a position rearward of the string trimmer (see Fig 2) and to a second position adjacent the elongate shaft (13), however, now being located just to the rear of the elongate shaft (13) (not shown).

Referring to Figure 2, the plant protector (20) is made of transparent plastics material and comprises, a body (207), a first elongate side member (241), and a second symmetrical elongate side member (242). The first side member (241) is located on one side of the body (207) and extends from the body (207) to the first pivot point (211). The second side member (242) is located on the other side of the

body (207) and extends from the body (207) to the second pivot point (212) in symmetrical fashion to the first side member (241).

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The first (241) and second (242) side members each have a hexagonal collar (201) located at the end of the side member away from the body (207) as shown in Figure 6. The hexagonal collar (201) of the first (241) and second (242) side members form part of the first (211) and second (212) pivot points respectively. The body (207) is similar in shape to a motor cycle crash helmet visor. The body (207) has a first edge (208), and a second edge (209), each edge describing an arc. The radius of the spherical section of the body (207) is sufficiently greater than the outer radius of the protection guard (17) so that the plant protector (20) can rotate about the pivot points (211;212) through its full range of pivotal movement without making contact with the protection guard (17) as best shown in Figure 2. The first (211) and second (212) pivot points act together as both pivotal support and latch mechanism for the plant protector (20). The pivot points (211;212) are capable of releasably latching the plant protector (20) in up to six different pre-determined pivotal stationary positions, or allowing rotational movement of the plant protector (20) in relation to the guard (17) when urged by the user. In particular, the pivot points (211;212) are formed so that three of the six stationary positions can hold the plant protector in either a 'storage' (Figure 2), a 'trimming' (Figure 3) or an 'edge cutting' (Figure 4) position.

There now follows a description, with reference to Figures 2 to 4, of the plant protector (20) located in these three stationary positions.

Figure 2 shows the plant protector (20) in the "storage" position. The body (207) of the plant protector (20) is located behind the guard (17). In the storage position the plant protector (20) surrounds part of the rear outer surface of the protection guard (17), the protection guard (17) surrounding approximately half the circular path swept out by the rotating cutting line (19). The plant protector (20) is not in use when located in the storage position.



Figure 3 shows the plant protector (20) in the "trimming" position where the plant protector projects forward of the string trimmer. The body (207) of the plant protector (20) is located at the front of the motor housing (16) and projects forward. The second edge (209), as viewed from the side in Figure 3, is located in a plane X-X, the plane X-X being substantially parallel to the ground and being the closest part of the plant protector (20) to the rotating cutting line (19). The path swept out by the rotating cutting line (19) is also parallel to the ground and is located just beneath the plant protector (20). The rotating cutting line (19) is located closer to the ground than the edge (209) in order to cut low-level vegetation like, for example, grass while other overhanging plants are pushed away by the body (207) of the plant protector (20) and therefore protected from the rotating cutting line (19).

Figure 4 shows the plant protector (20) in the "edge cutting" position the plant protector is still projecting forward of the string trimmer. The cutting head (18) of the string trimmer (10) is orientated so that the path swept out by the rotating cutting line (19) is vertical. When the path swept out by the rotating cutting line (19) is vertical, the string trimmer can be used to cut grass overhanging the vertical edge of a grass lawn adjoining a flower bed. The motor housing (16) is located on the grass lawn side of the path swept out by the rotating cutting line (19), and the plant protector (20) is located on the opposite side of the path swept above the flower bed. The first edge (208), as viewed from the side in Figure 4, is located within a plane Y-Y, the plane Y-Y being parallel to the ground and being perpendicular to the path swept out by the rotating cutting line (19). In the "edge cutting" position the plant protector (17) acts as a shield surrounding part of the upper half of the path swept out by the rotating cutting line (19) thereby protecting those plants and flowers rooted in the flower bed and overhanging the vertical edge of the lawn from the rotating cutting line (19).

The first (211) and second (212) pivot points are located on opposite sides of the guard (17) and are constructed in the same manner. A description of the construction of the plant protector of the first pivot point (211) is equally applicable to the construction of the second pivot point (212). The construction of the first pivot point (211) will now be described with reference to Figures 5 to 9.

The pivot point (211) comprises:

- a) a raised section (171) moulded into the protection guard (17), the raised section (171) comprising an outer circular ridge (172), a central hub (173) having a threaded aperture (174), and three shoulders (175) extending radially in from the circular ridge (172) to the central hub (173) (see Figure 9);
- b) a hexagonal collar (201) moulded into the plant protector (20) having a circular internal aperture (203), the hexagonal collar (201) having six outer flats (202) inter-posed by six 'v'-shaped troughs (204), the flats (202) each comprising a mid-point (205) and two extreme-ends (206), an extreme-end (206) being formed at the transitional point between a flat (202) and its adjacent trough (204) (see Figure 6);
- c) a circular cap (22) made of resilient material, comprising a perimeter wall (227) and three tongues (221), wherein the three tongues (221) form part of the perimeter wall (227), each of which is capable of resilient deformation and each one has a protrusion (222). The circular cap (22) further comprises a central collar (223) forming an aperture (224) and an annular raised portion (225) located in the annular space between the collar (223) and the perimeter wall (227). The annular raised portion (225) has three grooves (226) on its outer surface. Each of the three grooves (226) is adapted to simultaneously receive one of the three shoulders (175) when the pivot point (211) is assembled (see Figure 5);
- d) a threaded bolt (23) forming the axis of rotation (231) of the pivot point (211).

Assembly of the pivot point (211) is a three stage process:

Firstly unite the cap (22) and the plant protector (20) so that the raised portion (225) of the cap (22) is received by the aperture (203) on the plant protector (20) (as shown by Figure 5) and the hexagonal collar (201) is received by the annular trough located between the annular raised portion (225) and the perimeter wall (227) of the cap (22) (as shown in Figures 5 and 6), such that each protrusion (222) makes contact with the mid-point (205) of one of the flats (202) without resilient deformation of the tongue (221).

Secondly, unite both the cap (22) and the plant protector (20) with the guard (17) so that the hub (173) of the guard (17) is received by the aperture (224) of the cap and

the raised portion (225) engages with the three shoulders (175), such that each shoulder (175) is received by one of the three grooves (226) in the raised portion (225) thereby preventing rotational movement of the cap (22) relative to the plant protector (20).

- 5           Thirdly, securely fix the cap (22) to the guard (17) with the bolt (23) which engages with threaded aperture (174) of the guard (17).

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10           The pivot points (211;212), once assembled, allow rotational movement of the plant protector (20) relative to the guard (17) and the cap (22), subject to interaction between the protrusions (222) on the tongues (221) and the troughs (204). The six flats (202) and six troughs (204) of the hexagonal collar (201) form part of, and move with, the plant protector (20). Each flat (202) is arranged so that the distance between its mid-point (205) and the axis of rotation (231) is smaller than the distance between one of its extreme ends (206) and the axis of rotation (231). When a protrusion (222) makes contact at the mid-point (205) of an adjacent flat (202) the tongue (221) on which is mounted that protrusion is not deformed. However, should a protrusion (222) slide towards an extreme end (206) of that same flat (202), due to rotation of the plant protector (20) relative to the guard (17) and the cap (22), then the protrusion (222) is pushed radially outwards and away from the axis of rotation (231) due to contact with the flat (202) and, resiliently deforms its tongue (221). The resilient nature of the tongue (221) resists the sliding of the protrusion (222) from the mid-point (205) to the extreme-end (206).

25           Moving the protrusion (222) further from the mid-point (205) and beyond the extreme-end (206) engages the protrusion (222) with a 'v'-shaped trough (204). The distance between the bottom of the trough (204) and the axis of rotation (231) is smaller than the distance between the extreme-end (206) and the axis of rotation (231), therefore the deformation of the tongue (221) is reduced once the protrusion (222) passes the extreme-end (206) and engages with the trough (204). Once the protrusion (222) is engaged with the trough (204) the resilient nature of its tongue (221) resists movement of the protrusion (222) from the trough (204).

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The protrusions (222), the flats (202) and the troughs (204) are all mutually aligned so that if one protrusion (222) is engaged with a trough (204) then each of the other two protrusions (222) are simultaneously engaged with the other troughs (204). Equally, if one protrusion (222) is located at the mid-point (205) of a flat (202) then each of the other protrusions (222) is simultaneously located at the mid-point (205) of a flat (202), and so on. The first (211) and second (212) pivot points resist relative rotational movement between the guard (17) and the plant protector (20) because this involves the protrusions (222) moving from one trough (204) to engage with another trough (204).

This acts as a latch mechanism, only allowing rotational movement of the protrusions (222) between two troughs (204) when a sufficient rotational force exerted by the user is great enough to overcome the resilient force of the tongues (221). Conversely, the effect of gravity upon the mass of the plant protector (20) does not exert a great enough rotational force about the axis of rotation (231) to overcome the resilient force of the tongues (221) and cause rotational movement of the protrusions (222) between two troughs (204). Therefore the first (211) and second (212) pivot points hold the plant protector (20) stationary in relation to the protection guard (17) in any one of six positions provided each protrusion (222) is engaged with a trough (204). These six positions are pre-determined by the orientation of six troughs (204) relative to the plant protector (20).

During its life, a string trimmer risks being stored for a long time with the plant protector (20) positioned relative to the protection guard (17) in such a way that the protrusions (222) are not engaged with a trough (204). In such a case, each protrusion (222) must instead be located somewhere upon the surface of an adjacent flat (202). This location may be the extreme end (206) of the flat (202) causing continual deformation of the tongue (221). Over time, continual deformation of the resilient material forming the tongues (221) may result in plastic deformation of the tongues (221). Once plastically deformed, the tongues (221) lose their resilience and are unable to fully engage their protrusions (222) with the troughs (204). Once this has happened, the holding force of first (211) and second (212) pivot points is reduced. In

cases of extreme deformation the effect of gravity upon the mass of the plant protector (20) can be sufficient to exert a great enough rotational force about the axis of rotation (231) to overcome the what remains of resilient force of the tongues (221).

5 In this embodiment such a risk is reduced due to the inclusion of the flats (202) between the troughs (204). If each protrusion (222) is located at one extreme end (206) of the flat (202) then the protrusion (222) and hence the tongue tends to slide along the surface from the extreme end (206) to the mid-point (202) reducing distance between the axis of rotation (231) and protrusion. The tongue (221) is resiliently  
10 deformed when its protrusion (222) is located at one extreme end (206). However, the same tongue (221) is not deformed when its protrusion (222) is located either at the mid-point (202) or is engaged with one of the troughs (204). If a string trimmer is stored with each protrusion (222) located at one extreme end (206) then, the resilient nature of the tongue (221) urges its protrusion (222) to slide towards the mid-point  
15 (205) of the same flat (202) where the tongue (221) is no longer deformed. The use of flats (202) between troughs (204) provides a means of reducing the likelihood that the tongues (221) do not become plastically deformed. Therefore, the performance of the latching mechanism is less likely to deteriorate over time.

20 Though Figure 3 shows the plant protector (20) located above the cutting line (19), the plant protector can be pivoted downwardly so that it surrounds the front half of the path swept out by the cutting line. When in this position, the protrusions (222) are engaged with the flats (202).

25 The second embodiment of the present invention will now be described with reference to Figures 10 and 11.

The same reference numbers have been used to describe the second embodiment as the first embodiment except where the design has been changed.

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The design of the second embodiment of the present invention is the same as that of the first embodiment except that the hexagonal collar (201) on the plant

protector of the first embodiment of the invention has been replaced by a circular collar (300) as shown in Figure 11. The circular collar (300) comprises six flats (302) which are curved, each flat (302) having a radius of curvature about the axis (304) which passes through the centre of the collar (300) and which is the same as the other flats (302). Between each pair of flats (302) is located a trough (204), there being six troughs in total.

The second embodiment of the present invention works in the same manner as the first embodiment. When the protrusion (222) on the tongue (221) of the cap (22) is rotated from a position where it is engaged with a trough (204) to a position where it engages with a flat (302), the tongue resiliently deforms outwardly. However as the protrusion continues to rotate relative to the circular collar (300) it slides along the surface of the flat (302) of the circular collar (300), the amount of deformation of the tongue (221) remains constant as it slides along the flat (302) until it reaches the next trough where it engages with the trough to latch the pivot mechanism and hence the plant protector into a latched position.

The orientation of the troughs (204) about the axis (304) has been varied in the second embodiment to that of the first so that when the plant protector is in a forward projecting position in front of the cutting head (18) and the protrusions (222) are engaged with the troughs (204), it surrounds the front edge of the path swept out by the cutting line (19) when it rotates as shown in Figure 10.

The design of the third embodiment of the present invention will be described with reference to Figure 12 and is the same as that of the first except for the fact that the plant protector is mounted at its pivot points on the inside of the wall of the protector guard (17). Except for the plant protector (400) the same reference numbers have been used in Figure 12 as those used to describe the first embodiment. The guard is part circular in shape and is adapted to surround part of the rear of the path swept out by the rotating cutting line. The pivot points (not shown) are constructed in the same manner as those described in the first embodiment, the raised sector being moulded into the guard facing inwardly towards the cutting head (18), the hexagonal

collar on the plant protector and the cap being located within the space surrounded by the guard.

5 The radius of the plant protector (400) is less than that of the wall of the guard but greater than that of the path swept out by the rotating cutting line.

The plant protector pivots in the same manner as that of the first embodiment.

10 However, when the plant protector is pivoted to the "storage position" the top part of the plant protector locates to a position within the protection guard as shown in Figure 12 but surrounding the path swept out by the rotating cutting line.

15 It will be obvious to a person skilled in the art to reduce the width of the plant protector sufficient so that it is entirely located within the space surrounded by the guard when located in the "storage position".

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